Critical species of Odonata in the Asian part of the former USSR and the Republic of Mongolia

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Abstract

The region covered is briefly defined and characterized as relatively little disturbed. A survey of relevant odonatological literature, including local Red Lists, is given, along with current scientific activity. Sixteen species are indicated, which deserve special attention, one of them, *Ischnura aralensis*, being the only strict endemic in the region. Some isolated populations deserving protection are indicated. Regions important for odonate protection are listed, including parts of the Russian Far East in which threatened Chinese populations find a northern refuge. Measures taken for nature protection in the countries considered are also discussed.

Regional definition

The region's boundaries are determined more by the history of political relationships between two neighbouring empires, the Russian and the Chinese, and their descendants, than by natural biogeographic criteria. In the north and east it is bounded by the Arctic and Pacific Oceans, respectively. Its southern boundary coincides with the border of the former USSR plus the Republic of Mongolia. From east to west, this includes the border between Korea and Russia, the Chinese border with east Russia, the Republic of Mongolia and again Russia, then Kazakhstan, Kyrgyzstan and Tajikistan, then the border of Afghanistan with Tajikistan, Uzbekistan, Turkmenistan and then the border between Turkmenistan and Iran. The western limit of the region, from north to south, roughly and inclusively coincides with the Ural Mountains (55-60°E), the Ural River and the Caspian Sea.

Biogeographically it occupies north-eastern Palaearctic. The conventional border of the so-called West and East Palaearctic along the Ural Mountains is justified by convenience only, and the East Palaearctic has been seldom considered as a unit since its Chinese part, until recently, was little known in the West and even less in Russia. This political border has resulted in a discontinuity of our knowledge of

the fauna, hence we cannot presently consider any natural zoogeographical area which includes all North Asia. The region is occupied by a sequence of natural zones from arctic tundras to temperate deserts. At most longitudes east to about 110°E, the habitat sequence includes tundras, forest tundras, taiga (coniferous boreal forest, subdivided into northern, middle and southern taiga), forest-steppe, (alternating patches of forest and steppe), steppe variants of increasing aridity, and deserts. Due to continentality and the relative aridity of the climate, the zone of temperate broad-leafed forest is absent, although forests and groves of birch, sometimes with aspen, are very common and form two subsequent zones: the special subtaiga zone and the forest-steppe zone in West Siberia. In the eastern, more oceanic part of the region, the temperate forest zone appears south of the taiga zone, where it is represented by polydominant broad-leafed/coniferous nemoral forests, the floristically impoverished descendants of the Tertiary forests. The eastern part of the southern regional limit intersects this zone and thus here the zonal sequence terminates. Large areas in the north-east, in southern Siberia and along the southern limit of the region west of about 100°E, are occupied by mountains which sometimes represent important faunistic barriers. The northern mountains are poor in odonate habitats, whereas in the south, mountainous areas provide good odonate habitat in otherwise arid areas. The density of human population is low to very low almost everywhere, except for some areas of S Siberia and the Central Asian Republics of the former USSR, so destruction of natural habitats is generally insignificant when compared with Europe. There is a great variety of natural habitats for Odonata: large rivers, numerous small rivers and rivulets, large and small natural lakes; artificial ponds and ditches. Swamps and wetlands occupy enormous areas, especially in West Siberia where they cover all its northern part, constituting the greatest wetland in the world. Nevertheless, harshness of the climate in the north and its aridity in the south, together with the generally west-east orientation of mountain chains that prevented longitudinal migrations of the biota during the Pleistocene climate oscillation, made the flora and fauna of the most of the region strikingly poor and mostly allochtonous. Only in western Central Asia and in the southern Pacific regions does diversity increase dramatically, since these areas include incursions of the Mediterranean and Manchurian floras and faunas, respectively. As it is a relatively thermophilic group, this general pattern of biodiversity is especially pronounced in Odonata.

State of the art

Studies on taxonomy, ecology and biodiversity

The study of the Odonata fauna of the Asian part of Russia began with Hagen's works (Hagen 1856, 1858). Subsequently many works were published containing mostly faunal lists for different places (Selys 1872, 1887; Bergroth 1881; Trybom 1889; Klapalek 1901; Grigoriev 1906; Bartenev 1908, 1909a, 1909b, 1909c, 1910a, 1910b, 1911a, 1911b, 1912a, 1914, 1915, 1919, 1921, 1930a, 1930b, 1930c, 1932, 1933a, 1933b, 1956, and more general papers by this author;

Vorontsovskii 1909, 1912, 1913; Kolosov 1914, 1916a, 1916b, 1922, 1927, 1929; Oguma 1915, 1926; Dyakonov 1926; Lavroff 1927; Sjöstedt 1927; Bartenev & Popova 1928; Kono & Tamanuki 1928; Wnukowskii 1928; Valle 1932; Popova 1933; Fridolin 1936; Okumura 1942; Asahina 1949, 1958; Gorodkov 1956; Schmidt 1957).

The numerous papers by B.F. Belyshev must be especially mentioned. He carried out a systematic and enthusiastic study of this area (Belyshev 1951, 1952, 1953, 1955a, 1955b, 1956, 1958a, 1960a, 1960b, 1961a, 1963, 1964a, 1964b, 1964c, 1965a, 1965b, 1966a, 1966b, 1968, 1973a; Belyshev & Gagina 1959; Belyshev & Kurentzov 1964; Belyshev & Stepanchuk 1965; Belyshev et al. 1971; Belyshev & Haritonov 1973; for Belyshev's more complete bibliography, see Haritonov & Kiauta 1975). Belyshev's work culminated in the monograph on the Odonata of Siberia, in the older, broad sense, including all the Far East (Belyshev 1973b, 1973c, 1974).

Later detailed investigations of the Uralian fauna were carried out by Haritonov (1974a, 1974b, 1975b, 1975c, 1975d, 1975e, 1975f, 1976, 1977, 1978a, 1978b, 1980). This work was updated by Bayanov (1974), Bayanov and colleagues (Zei-Nechaeva & Bayanov 1975; Boev et al. 1989) and recently by Yanybaeva (1999, 2002) and V.A.Yanybaeva & A.Yu. Haritonov (unpubl.). Several workers explored West Siberia and the Altai Mountains (Zaika 1974, 1977, 1979, 1982; Haritonov, 1977, 1978b, 1981; Zaika & Voronova 1979; Kosterin 1987a, 1987b, 1989, 1996; Smir-nova & Haritonov 1987; Sukhacheva 1989, 1996; Dronzikova 2000; Kosterin et al. 2001). Several papers deal with C and E Siberia (Haritonov 1975a; Belyshev et al. 1978; Haritonova 1990; Zaika & Kosterin 1992; Fukui 1992, 1996; Gorb et al. 1996; Kosterin 1999, 2004a). A number of investigations have been made in the Russian Far East (Belyshev et al. 1976, 1978; Zaika 1980; Gorb & Fursov 1990; Gorb 1991; Malikova, 1993, 1995a, b, c, 1997a, 1999; 2002; Haritonov & Malikova 1998; Paulson et al. 1998; Malikova & Ivanov 2001, 2003; Ivanov 2002a, b; Fukui 1992, 1993). Some taxonomic works covered the whole region (e.g. Belyshev & Haritonov 1974; Haritonov 1975a; Haritonov & Borisov 1990). The ecology of Odonata has been studied extensively (Haritonov 1975b, 1975d, 1975e, 1975f, 1977, 1978b, 1980, 1981, 1990, 1994; Zaika 1977, 1979, 1980; Zaika & Voronova 1977; Kosterin 1987b; Sukhacheva 1989; Haritonov & Popova 1993, 1996; Popova & Haritonov 1996, 1998; Popova 1999, 2001; Malikova 1999b; Dronzikova 2000, 2001). Sukhacheva (1996) even used advanced immunological methods and applied biochemical methods to identify early larval stages of aeshnid species (Sukhacheva et al. 2003). Karyological analysis of odonates from Siberia and the Russian Far East applied C-banding technique (Perepelov et al. 1998, 2001; Perepelov & Bugrov 2001a, 2001b, 2001c; Perepelov 2003). Beketov (2002) studied ammonia toxicity to larvae of three Siberian odonate species.

In summary, the taxonomy, faunistics and some aspects of the ecology of the region's odonates are satisfactorily known in general, although the possibility of new findings still exists. For instance, after Belyshev seven species were newly recorded in the Russian Far East (Malikova 1995a, 1995c; Malikova & Seidenbusch 2001) and another two, *Ischnura aralensis* and *Selysiothemis nigra*

(Van der Linden, 1825), in southern Ural (Haritonov 1988; Yanybaeva 1999, 2002). Yet knowledge of ranges, especially the northern limits of distribution, and of ecology and biology is still incomplete for all species.

Data on the odonates of the Central Asian republics of the former USSR has been accumulated for about 150 years in many publications ranging from casual faunistic records to checklists of some republics (Brauer 1877, 1880; Foerster 1900; Grigoriev 1905; Yakobson & Bianchi 1904; Bartenev 1911b, 1913, 1915, 1919, 1929, 1930a, 1939; Djakonov 1926a; Shorygin 1926; Sokolov 1933; Popova 1936, 1951, 1953; Starostin 1951; Panin 1958; Belyshev 1958b, 1961b; Belyshev & Shevchenko 1958, 1971; Gorodkov 1961; Krylova 1968a, 1968b, 1969, 1972; Chibichenko & Krylova 1968; Krylova & Chirov, 1971; Kumachev 1973; Haritonov 1979, 1980; Ionychev & Ibadulaev 1981; Kukashev 1982; Pavlyuk & Kurbanova 1984). In the 1980s, S.N. Borisov systematically investigated the odonates of this region (Borisov 1983, 1984, 1985a, 1985b, 1985c, 1986a, 1986b, 1987a, 1987b, 2002, 2004; Haritonov & Borisov 1983, 1985, 1990; Borisov & Haritonov 1986, 2001; Dumont et al. 1992, 1995; Dumont & Borisov 1993). After the dissolution of the USSR, this area has been less intensively investigated by Russian odonatologists but has been visited by researchers from the West. The most recent papers concern Tajikistan (Borisov 2002), Kazakhstan (Volkmann 1991; Reinhardt 1995, 1996, 1999; Dumont 1996, 1997; Reinhardt & Seidenbusch 1999; Chaplina 2003, 2004) and the region in general (Dumont et al. 1992, 1997; Jödicke et al. 2000; Schoorl 2000). Two papers by Borisov (2002, 2004) were devoted to altitudinal and habitat distribution of odonate species. A number of publications on the Asian part of the former USSR has been specially devoted to the protection of Odonata, discussing some aspects of protection or reporting data on rare species (e.g. Haritonov 1987; Haritonov & Haritonova 1989; Haritonov & Dronzikova 1996).

Rather few papers containing actual records have been devoted to the territory of Republic of Mongolia (Schiemenz 1956; Belyshev & Doshidorzhi 1958, 1960; Benedek 1968; Krylova 1974; Peters 1981; Fukui 1995; Malikova 1997b; Kosterin 1999, 2004a; Dumont 2003). Two earlier papers, which mentioned "Mongolia" (Sjöstedt 1932; Valle 1942), in fact dealt with material outside this country (Krylova 1974). Peters (1981) also provided morphometric data with respect to continental isolation of populations in the arid zone.

Identification guides

B.P. Bianchi published the first guide to the imaginal and larval (up to family level) stages of odonates of the Russian Empire and adjacent countries, including Mongolia (Yakobson & Bianchi 1904). This guide still retains its importance. The next guide was by Djakonov (1926b), covering 46 odonate species, both imagines and larvae, of Leningrad Province, but relevant to a large part of our region. Later, identification keys covering the entire territory of the former USSR were published only for odonate larvae (Popova 1953; Haritonov 1997). An illustrated guide of wing venation for all odonate species of the former USSR was published by Belyshev & Haritonov (1977). Belyshev (1963) wrote a guide to adults and larvae

of odonates of the Asian part of Russia. Such keys were also included in his monograph (Belyshev 1973b, 1973c, 1974). Keys to adult Odonata were included in the multi-volume guides for the insects of the European part (Spuris 1964) and of the Far Eastern part of the USSR (Haritonov 1986).

Newer identification keys to larval and adult Odonata of the region were given in the unpublished dissertations of Borisov (1987b: Central Asian republics of the former USSR) and of Malikova (1995c: Russian Far East). The current unavailability of an up-to-date identification guide is an unfortunate gap in the relevant literature. There is no guide for Republic of Mongolia but the Siberian ones are very useful for this region.

Faunal lists

Up-to-date faunal lists for particular areas of the Russian part of the region are as follows:

Ural — Haritonov 1976; Yanybaeva 2002; V.A. Yanybaeva & A.Yu. Haritonov (in prep.)

West Siberian Lowland — Sukhacheva 1989

Tom' River basin — Dronzikova 1999

Tyva Republic (Tuva) in Central Siberia — Kosterin & Zaika 2004

SE Transbaikalia (Dahuria) — Kosterin 1999, 2004a

Amur Province — Malikova 1997a

Primorskii Krai Province — Malikova & Ivanov 2001

Yakutia — Kosterin 2004b

Sakhalin — Ivanov 2002b

Kamchatka — H.J. Dumont, A.Yu. Haritonov, O.E. Kosterin, E.I. Malikova and O.N. Popova (in prep.)

A general checklist of the Russian part of the territory considered was provided several times by B.F. Belyshev, especially in his monograph "Dragonflies of Siberia" (Belyshev 1973b, 1973c, 1974). Subsequently , Belyshev (1976), Spuris (1988) and Belyshev et al. (1989) gave checklists for the whole territory of the USSR, including 161 (159 is erroneously counted), 160 and 174 (172 is erroneously counted) species, respectively; note that the area included the European part, which is not considered here. Distribution maps are provided in Belyshev (1968, 1973b, 1973c, 1974).

All these general checklists are today out-of-date. According to our present knowledge, 125 species occur in the Russian part of the region, taxonomically doubtful species excluded (cf. Table 1). Note that in the total territory of the Russian Federation, including its European part not considered here, 143 species are recorded. Only two of them, the western *Lestes viridis* (Vander Linden, 1825) and *Erythromma lindenii* (syn *Cercion*) (Selys, 1840), are absent from the entire region considered here.

Several checklists cover the Central Asian republics of the former USSR: Kazakhstan (Belyshev & Shevchenko 1971; Chaplina 2004); Kyrgyzstan (Krylova 1969); Tajikistan (Popova 1951; Borisov & Haritonov 1986; Borisov 1987).

Following the two general faunal lists of the entire USSR (Belyshev 1976; Spuris 1988), the odonate fauna of the Central Asian republics of the former USSR, viz Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan, was compiled and annotated by Borisov & Haritonov in Belyshev et al. (1989). However, north and east Kazakhstan, where a number of northern species invade, were beyond the scope of this list, so the total number of odonate species inhabiting the former republics cannot be reliably inferred from these sources. Preliminarily, with some corrections, especially reducing the number of *Calopteryx* species, the total number of odonate species of all former Central Asian republics can be estimated to be 102.

The Republic of Mongolia has a comparably poor odonate fauna which was listed in Belyshev (1961a), Krylova (1974), Belyshev & Haritonov (1981), Peters (1985), Kosterin (1999, 2004a) and Dumont (2003). Altogether 46 species are reliably known from this country. We should stress that the Mongolian specimen thought to represent the doubtful Chinese species *Aeshna lucia* Needham, 1930 (Belyshev & Doshidorzhi 1958) was re-examined by E. Malikova and proved to be *A. juncea* (Linnaeus, 1758) with a darkened face, so *A. lucia*, which itself is most probably a synonym of *A. mixta* (Asahina 1988), is deleted from the Mongolian list.

According to our present-day faunistic knowledge and taxonomic notions, 162 odonate species occur in the region as a whole.

Critical species

Notes on species previously listed by IUCN

The 2003 IUCN Red List of threatened species (IUCN 2003) includes only one species occurring in the region: *Aeshna viridis* (Eversmann, 1836) with a status LR/NT (lower risk, nearly threatened). This species is known for its peculiar larval habitat, by prefer-ence for the interleaf space of the submerged plant *Stratiotes aloides*. It is a

Table 1. Odonata of the region of uncertain taxonomic status.

Species	Distribution	Occurrence	Notes
Calopteryx unicolor Bartenev, 1912			
	Uzbekistan	Most probably teneral specimens of *C. samarcandica* Bartenev, 1912 were described under this name	Dubious records
Aeshna undulata Bartenef, 1930			
	S Ural (?)	Probably a junior synonym of *A. juncea* (Linnaeus, 1758)	Known only from the holotype, which is lost
Trigomphus anormolobatus Bartenev, 1911			
	South of Primorskii Krai Province	Probably a senior synonym of *T. ogumai* Asahina, 1949	Not found after description

common plant of river oxbows. In western Europe it is greatly diminished owing to river regulation and active distruction by anglers. This is why *A. viridis* also declines there. In Russia it is still a widespread and abundant species. Although it may be scarce in European Russia, in the valleys of the great and smaller rivers of the lowlands of West Siberia this is one of the most numerous of all aeshnid species. Moreover, its abundance was formerly underestimated since this is the only Siberian species exhibiting mostly crepuscular activity. We see no threat to this species.

Species to be considered

Most of odonate species of the region have a wide range and high abundance, except for those species entering the region near the limit of their ranges. Many species that are rare or threatened in Europe are common in some parts of Siberia or Central Asia, e.g. *Coenagrion armatum* (Charpentier, 1840), *C. hylas* (Trybom, 1889), *Aeshna crenata* (Hagen, 1856), *A. serrata* (Hagen, 1856), *Somatochlora sahlbergi* Trybom, 1889, or *Sympetrum depressiusculum* (Selys, 1841). We can scarcely name any species of all our area as endangered, but more than 30 species are rare or have a very local distribution. In Russia, most of them occur at the northern limit of their ranges and are common elsewhere, such as *Platycnemis phyllopoda* Djakonov, 1926 and *Deielia phaon* (Selys, 1883) which are abundant in Korea; or *Lestes japonicus* Selys, 1883, *L. temporalis* Selys, 1883, *Paracercion hieroglyphicum* (syn. *Cercion*) (Brauer, 1865), *Mortonagrion selenion* (Ris, 1916), *Aeschnophlebia longistigma* Selys, 1883, *Anotogaster sieboldii*, *Orthetrum melania* (Selys, 1883) and some others which are common or abundant in Japan; or *Paracercion plagiosum*, *Anisogomphus maacki* (Selys, 1872), *Gomphidia confluens* Selys, 1878 and *Ophiogomphus spinicornis* Selys, 1878 which are common in China.

The Manchurian centre of endemism, embracing the mountainous area of the Korean peninsula, NE China and Primorskii Krai in Russia, harbours three rare species occurring only in this region: *Asiagomphus melanopsoides*, *Shaogomphus schmidti* and *Macromia manchurica*. Two more are known only from Korea: *Asiagomphus coreanus* (Doi & Okumura, 1937) and *Nihonogomphus minor* Doi, 1943 and might be found within the limits of Russia. Thorough researches are necessary for estimation of range limits and population status of these species. All except *S. schmidti* are known from few records, with almost no data on their biology. A rather large population of *S. schmidti* was recently found in Khanka Lake basin (Ivanov 2002; Malikova & Ivanov 2003).

In Central Asia there are also several species found at the northern limits of their ranges. Within the region they are regarded as rare although abundant populations exist elsewhere (Borisov & Haritonov in Belyshev et al. 1989). For instance, at the foothills of the Kopet-Dagh and Kugitangh Mountains bordering Turkmenistan in the south, a number of eastern Mediterranean species are found at their north-eastern range limit, such as *Epallage fatime* (Charpentier, 1840), *Coenagrion ornatum* (Selys, 1850), *Caliaeschna microstigma* (Schneider, 1845), *Anormogomphus kiritschenkoi*, *Gomphus davidi* Selys, 1887, *G. schneideri* Selys, 1850, *Onychogomphus assimilis*, *O. lefebvrei* (Rambur, 1842) and *Trithemis festiva* (Rambur, 1842) (Borisov & Haritonov in Belyshev et al. 1989). There are, however, species not common throughout their ranges or in their considerable parts and possibly are under some threat, such as *A. kiritschenkoi* or *G. davidi*.

The western species *Cordulegaster boltonii* deserves special attention. It was reported from South Ural (Zei-Nechaeva & Bayanov 1975). We have no other records of this species from our region, so further information is welcome. Sixteen species are considered as rare or locally distributed (Table 2). Data on Korea are given by Lee (2001) and on the East Mediterranean by Ketenchiev & Haritonov (1999).

We must note that every species from the list may be qualified as 'data deficient', because almost all knowledge about them in North and Central Asia is restricted to limited geographic records and short notes on their biology. Special information is needed to place species on a Red List, and at present not a single regional species fulfils the required criteria. However, we can propose to include at least *Ischnura aralensis*, *Asiagomphus melanopsoides*, *Shaogomphus schmidti* and *Macromia manchurica* in the next version of the IUCN Red List under the category LR/NT (lower risk, nearly threatened).

Endemic species

The only endemic species is *Ischnura aralensis* (syn. *calicis* Bartenev nom. nud.), so far found in Kazakhstan and Russia. In Kazakhstan its few records are scattered over a vast arid area from East Kazakhstan Province to the Aral Sea, with the most abundant populations found in Kzyl-Orda Province (Haritonov 1979, 1988; Chaplina 2003). In Russia it was found on lakes Alakul' and Kisegach in Chelyabinsk Province (Haritonov 1988) and in a quite woody area of the Abzezil lake group in Bashkortostan (Vanybaeva 2002; V.A. Yanybaeva & A.Yu. Haritonov in prep.). The combination of a small number of known localities over a wide area ranging from semi-deserts to forests with an unique female-linked morphological and colour polymorphism (Haritonov 1988; V.A. Yanybaeva & A.Yu. Haritonov in prep.) makes the species one of the most intriguing and least understood among our odonates.

Calopteryx samarcandica Bartenev, 1911 (syn. *maracandica* Bartenev, 1913) is almost endemic, ranging in the mountains of Tajikistan and southern Uzbekistan and Kyrgyzstan but also in N Afghanistan and, perhaps, N India. This taxon occurs sporadically in foothills and mountains but is most probably not threatened at all.

There is a considerable number of species described as being endemic to the region, mostly by Bartenev and, to lesser extent, Belyshev. All of them were sooner or later synonymized with widespread species. These synonymizations were published in Russian language and in obscure publications. This is why several synonymizations have never been recognized outside Russia. Further synonyms will be unmasked in international journals in the near future. There is no need to enumerate the synonyms in this report, because they all refer to the region exclusively. Three obscure species that have not been convincingly synonymized so far, all described by Bartenev, are given in Table 1.

Isolated and restricted populations

In the region some species have disjunctive ranges, with enclaves isolated from the main population by thousands of kilometres. They are represented by very small and local populations, deserving special attention and protection.

Orthetrum albistylum (Selys, 1842) has very northern populations living only at hot springs close to southern and northern ends of Lake Baikal (the Sosnovka and Verkhnyaya Angara River basins) and Chara Hollow (Lake Arbakalir) in northernmost Chita Province, discovered and investigated by Belyshev (Belyshev & Gagina 1959; Belyshev 1960b, 1973b; Belyshev et al. 1978). Currently they were also found at hot springs at Lake Baunt (P. Ustjuzhanin pers. comm.). These peculiar populations exist solely due to their unique geothermal habitat and must be protected together with it.

Two populations of the East Asiatic *Sympetrum croceolum* were unexpectedly discovered in West Siberia: in 1982 at Lake Manzherok in the northern Altai Mountains (Kosterin 1987a) and in 1987 in the Suzunskii Bor pine forest at Meret' village in SE Novosibirsk Province (Haritonov in Belyshev et al. 1989). There is also one record of a probably migrating individual, which was spotted in 2000 by E. Shtrekker within the city of Novosibirsk (Kosterin et al. 2001), ca 160 km north of Suzunskii Bor. The western limit of the main East Asiatic population is in the middle reaches of the Amur River (Malikova 1993, 1997a). The two disjunct populations seem to be strictly confined to their lakes. West Siberian specimens show some difference from the Far Eastern ones and may represent a new subspecies. Lake Manzherok is situated in a rather densely populated area and suffers strongly from tourism activity and the regulation of its water regime, which makes it very vulnerable. The Suzunskii Bor pine forest is much less under threat.

A population of *Coenagrion ecornutum* (Selys, 1872), though mainly ranging from West Altai to Japan, has been discovered on the Uchal lake group in Bashkortostan, S Ural (Yanybaeva 1999; V.A. Yanybaeva & A.Yu. Haritonov in prep.). This isolated population is quite abundant.

Somatochlora graeseri Selys, 1887 also inhabits the Ural and is probably isolated from its main range, with the Altai as the westernmost edge. However, its Uralian population seems to be not threatened yet. In the Polar Ural it is found together with another Siberian species, *Coenagrion hylas*. These two species may be isolated or represent a northern westward projection of their ranges (Belyshev & Haritonov 1980). Anyway, Polar Ural is a scarcely populated virgin land not threatened in the foreseeable future.

Two generally East Asian anisopterans, *Shaogomphus postocularis epophthalmus* and *Macromia amphigena fraenata* Martin, 1907 (syn. *sibirica* Djakonov, 1926), occur as isolated populations in W and C Siberia at the north-western margin of the Altai-Sayan mountain system, namely in southern Krasnoyarsk Province, Kemerovo Province, eastern Novosibirsk Provinces and eastern Altaiskii Krai Province (Haritonov 1981; Kosterin et al. 2001; O.E. Kosterin unpubl.). *M. a. fraenata* has also been found in Kazakhstan (Chaplina 2003; K. Reinhardt pers. comm.) and the western Republic of Mongolia (Peters 1985). These isolates are large and both species are common on some medium-sized rivers in wooded hilly land, usually occurring together. However, they deserve attention as Holocene relics (O.E. Kosterin unpubl.). While *M. a. fraenata* is common in the Russian Far East, *S. p. epophthalmus* is rare in this area and abundant populations are found only in West Siberia. This is far from Japan, which is inhabited by the rather abundant nomino-typical subspecies.

Table 2. Rare or locally distributed odonate species in the region.

Family/species	Distribution	Status	Cause of decline/threat
Coenagrionidae			
Ischnura aralensis Haritonov, 1979			
	South Ural; Kazakhstan	Few records from different environments, some populations abundant	Habitat change or habitat destruction
Mortonagrion selenion (Ris, 1916)			
	S Primorskii Krai; also Korea, Japan	Very local in the continent; common in Japan	Habitat change or habitat destruction
Nehalennia speciosa (Charpentier, 1840)			
	S Asian Russia, from Ural to Pacific ocean; also Korea; Europe	Patchy distribution in Russia; only a few records from Korea. Some populations in West Siberia and the Amur River basin seem stable	Habitat change or habitat destruction
Paracercion plagiosum (syn. *Cercion*) (Needham, 1930)			
	S Primorskii krai; also Korea, China	Only a few records from Russia, local populations in Korea; probably common in China	Unknown
Platycnemididae			
Copera tokyoensis Asahina, 1948			
	S Primorskii Krai; also Korea, Japan, C and N China	Rare on the continent; more common in Japan. There are few stable populations in Primorskii Krai	Habitat change or habitat destruction
Aeshnidae			
Aeshna subarctica Walker, 1908			
	N Siberia from Ural to Kamchatka; also N Europe and America	Only a few records from Asian Russia	Unknown
Gomphidae			
Anormogomphus kiritschenkoi Bartenev, 1913			
	SW Tajikistan, S Uzbekistam, S Turkmenistan, S Kazakhstan, also Afghanistan, Iran, Iraq, Turkey	Everywhere rare and local, the only abundant population known from the Kara-Kumskii channel at Ashkhabad.	Unknown, seems not to suffer from human activity.

Family/species	Distribution	Status	Cause of decline/threat
Gomphidae (continued)			
Asiagomphus melanopsoides (Doi, 1943)			
	S Primorskii Krai; Korea	A single record from Russia, rare in Korea.	Unknown
Shaogomphus postocularis epophthalmus (Selys, 1872)			
	S Siberia, the Amur River basin; also Korea, Manchuria	Patchy distribution in Russia, not abundant in Korea.	Unknown
schmidti (Asahina, 1956)			
	Primorskii Krai; also E Manchuria; ?Korea	Few populations known from Russia, single record in Manchuria	Unknown
Stylurus annulatus (Djakonov, 1926)			
	S Khabarovskii and Primorskii Krai; also Manchuria, Korea, Japan	Rare in the continent; more common in Japan.	Unknown
Cordulegastridae			
Cordulegaster boltonii (Donovan, 1807)			
	One record for Bashkiria (S Ural), also Europe	Local, stenotopic	Strongly depends on quality of lotic habitats
Corduliidae			
Macromia manchurica Asahina, 1964			
	Primorskii Krai; also E Manchuria, Korea	Only few known records.	Unknown
Somatochlora alpestris (Selys, 1840)			
	Low mountains from Ural to Kamchatka; also Korea, Japan; Europe	Rare; patchy distribution, restricted to mountains	Unknown. Probably competition with other species of the same genus
Libellulidae			
Sympetrum croceolum (Selys, 1883)			
	SW Siberia, the Amur River basin; also Korea, Japan, Manchuria, C China	Disjunctive range in West Siberia; local distribution in the southern Far East of Russia and Korea.	In the western range extreme locality and confindeness to few vulnerable habitats, in the east unknown
uniforme (Selys, 1883)			
	The Amur River basin; also Korea, Japan, Manchuria, N China	Low density of populations in the Southern Far East of Russia and Korea.	Unknown

Regional Red Lists

In the second edition of the Red List of the USSR (Haritonov 1984) 11 odonate species from the region were included: *Epallage fatime*, *Ischnura aralensis*, *Caliaeschna microstigma*, *Anormogomphus kiritschenkoi*, *Onychogomphus assimilis* (Schneider, 1845), *Anotogaster sieboldi* (Selys, 1854), and *Cordulegaster insignis* (Schneider, 1852). Unfortunately, in spite of suggestions by the expert author responsible for odonates, A.Yu. Haritonov, the committee responsible for the Red List of the Russian Federation rejected all these species and included in the new edition only one odonate species, *Anax imperator* Leach, 1865 (Haritonov 2001). Its inclusion is hardly justified; the committee just chose the largest species of the Russian fauna.

In 1991 the Red List of the Kazakh SSR (Haritonov 1991) has been published. It included seven odonate species: *Calopteryx virgo* (Linnaeus, 1758), *I. aralensis*, *A. imperator*, *A. kiritschenkoi*, *C. insignis*, *Orthetrum sabina* (Drury, 1773), and *Selysiothemis nigra*. We have no information whether Odonata in other former USSR Central Asian Republics were protected by legislation.

In recent years, the units of the Russian Federation – provinces, krais and republics – rushed to publish their local Red Lists. Most of them include Odonata: *Sympetrum pedemontanum* in the list of the Bashkirian ASSR (presently of no legacy) (Migranov et al. 1987); *Anax imperator* in that of Orenburg Province (Rusakov 1998); *Calopteryx splendens* (Harris, 1782), *C. virgo*, *Brachytron pratense* (Müller, 1764), *Libellula depressa* Linnaeus, 1758 and *Orthetrum cancellatum* (Linnaeus, 1758) in that of Kurgan Province (Utkin 2002); *C. virgo*, *C. splendens*, *Ischnura elegans* (Vander Linden, 1823) and *Nehalennia speciosa* in that list of Khanty-Mansi National Region (Krasutskii & Olshvang 2003); *Shaogomphus postocularis epophthalmus* (as *G. epophthalmus*), *Macromia amphigena fraenata* and *Sympetrum croceolum* in that of Novosibirsk Province (Haritonov 2000); *C. splendens* in that of Tomsk Province (Romanenko et al. 2000); *Nihonogomphus ruptus*, *Stylurus flavipes*, *S. p. epophthalmus* (as *Gomphus epophthalmus*), *Somatochlora graeseri*, *M. a. fraenata* (as *M. sibirica*), in that of Kemerovo Province (Gagina et al. 2000); *C. virgo* in that of Altaiskii Krai (Perunov 1998); *N. speciosa*, *Anax parthenope* Selys, 1839, *M. a. fraenata* (as *M. sibirica*) and *S. croceolum* in that of the Altai Republic (Kosterin & Zaika 1996); *Ophiogomphus spinicornis* in that of the Tyva Republic (Kosterin 2002); *Calopteryx japonica* Selys, 1869 and *C. splendens* in those of the Ordynskii Buryat Autonomous Region (Shilenkov 2003) and of Irkutsk Province (V.G. Shilenkov still unpubl.); *Paracercion v-nigrum* (syn. *Cercion*) (Needham, 1930), *Anisogomphus maacki*, *Anax parthenope*, *Somatochlora sahlbergi* and *Pantala flavescens* (Fabricius, 1798) in that of Chita Province plus the Aginskii Buryat Autonomous Region (Kosterin 2000); *C. japonica* in that of the Sakha Republic, Yakutia (N.N. Vinokurov still unpubl.). The publication of these books and the choice of included species are justified by a special act of local legislation, but their influence is slight. The reasons for the inclusion of many of these are disputable if not absurd. The only odonate included into the Red List of the Republic of Mongolia is *Aeshna juncea* (Anonymous 1977) – also not justified (Dumont 2003).

Critical sites and threats

The worst anthropogenic problems for odonates are caused by oil-extraction, mining, power engineering, road construction and agriculture. These activities result in degradation of forests, pollution of water-bodies with fertilisers, pesticides and organic wastes and diversion and misuse of water. Construction of hydropower stations results in the regulation of flooding, aridification of floodplains and loss of oxbows. Another threat is the decrease of the level of ground water. Some species, on the other hand, may benefit from newly built reservoirs and channels, especially in the arid areas of Central Asia (Borisov 1985a, 2002; Haritonov & Popova 1996). However, the region, especially the northern tundra and taiga and the southern dry steppe, semi-desert and desert, remains perhaps the most virgin and least disturbed of all landscapes in the world.

Since the odonate fauna of the region is generally allochthonous, there are only few critical sites deserving special protection of Odonata. They are mostly situated at the southern border of the region. One is the southernmost area of the Russian Far East. Several Manchurian species penetrate this area and find there less destroyed forest habitats than in their core distribution in NE China. It is noteworthy that the exponentially growing economics and still rapidly growing human population of China pose a severe threat to habitats in Manchuria where the last natural landscapes will soon disappear. Presently, human population densities on both sides of the Russian/Chinese border differ by about tenfold, and it is Chinese demand for natural products which drives logging and other forest exploitation within Russia by Chinese migrants and local poachers. Thus, the outlying northern fragments of the Manchurian communities, within Russia, represent their refuge and are strongly threatened.

The woody area of Bashkortostan, S Ural, is another critical site to be considered. Here the local European species *Cordulegaster boltonii* and *Libellula fulva* O.F. Müller, 1764 meet with isolates of such Siberian species as *Coenagrion ecornutum* and *Somatochlora graeseri*. Recently, a thriving population of the endemic *Ischnura aralensis* (Yanybaeva 1999, 2002; V.A. Yanybaeva & A.Yu. Haritonov in prep.) was found.

In the Republic of Mongolia, its Dzhungarian exclave, Bulgan Somon, situated west of the principle range of the Mongolian Altai, is important as harbouring species not recorded from the rest of the Mongolian territory, such as the western species *Coenagrion puella* (Linnaeus, 1758) and *Somatochlora metallica* (Vander Linden, 1825), the Turanian species *Ophiogomphus reductus* Calvert, 1898 and, surprisingly, the eastern species *Macromia amphigena fraenata* (Peters 1985; Dumont 2003). However, this site is important only on a national scale. It results from the Chinese/Mongolian border crossing and recrossing the Altai, thus making a number of western species to occur in the territory of the Republic of Mongolia, but it has no significance from a biogeographical point of view. None of these species is endangered globally.

The mountains of Central Asian support a good diversity of Odonata (Borisov & Haritonov in Belyshev et al. 1989) which is well preserved. Moreover, many odonate species benefit from the construction of artificial water bodies (Borisov 1985a,

2002). Most vulnerable habitats are situated in the northern foothills of the Kopet-Dagh mountains, along the border between Turkmenistan and Iran. The area hosts a peculiar fauna, including *Calopteryx orientalis* Selys, 1887 (syn. *transcaspica* Bartenev, 1911), which occurs in the mountains at the southern Caspian coast (Dumont et al. 1997), and a number of representatives of the East Mediterranean fauna (Borisov & Haritonov in Belyshev et al. 1989). Unfortunately, Turkmenistan does not seem to be a country in which the need of nature protection is currently acknowledged.

Conservation priorities and recommendations

The protection strategy for odonates, as for most other invertebrates, should consist of two major elements:

— foundation and maintenance of protected territories
— conservation of habitats outside protected territories

Government policy in Russia tends only to address the first point. There are various types of protected areas in Russia with different levels of protection:

nature reserves (Russ. "zapovednik"), where all economic activity is prohibited, as a rule surrounded by a so-called buffer zone of a restricted regime of land use;

national parks, where only recreation is allowed;

federal, provincial or district refuges (Russ. "zakaznik"), where only some species of animals or plants are protected and some destructive activity is allowed, e.g. hunting or fishing in plant refuges;

nature monuments (Russ. "pamyatnik prirody"), small territories representing more or less unique nature objects, with restricted use allowed.

The number of protected areas has been steadily increasing over the last 10 years and the government is improving their status and financial support. Hence, 16 new nature reserves and more than 100 refuges have been founded in the Asiatic part of Russia since 1990, and the protected area has been more than doubled. We recommend the protection of new areas in the southern Far East of Russia, the zone with Manchurian elements in the flora and fauna, while at the same time considering economical and political interests. The lakes of the Abzelil group in Bashkiria, being a habitat of *Ischnura aralensis*, are not yet protected. These should be listed as a state refuge. Lake Manzherok in the Altai Republic, where free recreation and licensed fishing and hunting are allowed, should be turned into a nature refuge or nature monument as soon as possible.

Yet nature conservation is precarious in Russia. Legislation is inadequate, and there are virtually no mechanisms to make it working. Ecological education and public awareness of the condition and exploitation of nature should be increased. This would encourage politicians to develop better legislation for nature protection and also encourage local authorities to execute it more thoroughly.

The former USSR republics generally inherited the same system of nature protection. We have no actual data but indirect information is rather discouraging.

In Tajikistan, some reserves were recently used as battlefields, and government control over some mountainous areas is very weak (but nature is little affected there as well). In Turkmenistan all reserves were cancelled officially. The general decline of regulation in all the former USSR republics, including Russia but most profoundly in the new southern states, advances a kind of economic development, which is firstly directed to the exploitation of natural resources. Additionally, a trend towards privatisation of land without effective control of its use is creating a severe threat to the natural environment. Therefore, political development of the new states, increasing govern-ment power and educating society generally in environmental issues, are of the utmost necessity, not only for people but also for Odonata.

The Republic of Mongolia used to be very poorly developed but recently it has improved both economically and in social infrastructure. However, Odonata in Mongolia are generally limited by arid conditions rather than by human influences. Therefore, no special program for the conservation of odonates is needed in this country.

Research priorities

The main task now is to improve our knowledge of the distribution and abundance of odonate species in the region. Unfortunately, the lack of experienced workers and the fact that the vast north is almost inaccessible, make the monitoring of odonate populations very difficult. It is obvious that modern identification keys and illustrated atlases are urgently needed. Another important goal is to study habitat preferences and other aspects of the general biology of odonates, especially of rare species.

Current activities

There is no special project for the conservation of Odonata in Russia. It is prohibited to collect those species that are listed in regional or state Red Lists, except for scientific purposes, which requires a permit. However, this prohibition is not policed. Odonates are protected together with other animals and plants in nature reserves, and there are papers especially devoted to the fauna of some (Kosterin 1999, 2004a; Borisov & Haritonov 2001; Malikova 2002). The 52 nature reserves in Asian Russia cover about 2% of the region. According to estimations of non-governmental ecological organisations (such as Biodiversity Conservation Centre, <http://www.biodiversity.ru/eng>), the size of protected territories should be at least 5%.

An essential prerequisite for evaluation of the state of populations and protection of rare species of odonates is to accumulate sound, scientific information on these insects. The centre of odonatological studies in Russia was formed in the early 1960s within the Siberian Branch of the Academy of Sciences of the USSR. At that time odonatological work was officially included into the aims of the Institute of Biology in Irkutsk, thanks to the activity by B.F. Belyshev. In 1967 this programme was transferred (along with the move of Belyshev) to the Biological Institute in Novosibirsk. Hence, as well as a worldwide zoogeographical analysis of Odonata,

regular investigations of odonate faunistics and systematics have been carried out in different regions of the former USSR for more than 40 years to date. During the last ten years, three to four academic odonatologists, and a similar number of post-graduate students, permanently worked at the Institute of Systematics and Ecology of Animals of the Siberian Division of the Russian Academy of Sciences – the former Biological Institute. Odonatologists who produced their PhD theses at this institute now work at State Universities and State Pedagogical Universities of Novosibirsk, Kabardino-Balkaria, Blagoveshchensk, Novokuznetsk, Tuva, in the Bashkirian State Nature Reserve and the Tuvinian Institute of Complex Exploitation of Natural Resources (Kyzyl). Some qualified odonatologists work now in Novosibirsk, Moscow, Sanct-Petersburg, Vladivostok. Presently the total number of actively working odonatologists in Russia is about 20. The main scope of their research, as well as current topics of investigation by postgraduate students, is regional faunistics and ecology of odonates.

Four major current activities should be mentioned: (1) a two-year NATO collaborative Grant 979506 (Belgium-Germany-Russia-Kazakhstan), headed by H.J. Dumont (Ghent), with the aim of investigating the odonate fauna of Kamchatka and Kazakhstan; (2) preparation of a guide to the Odonata of the Russian Far East by E.I. Malikova; (3) completion of an overview of the odonate fauna of Kazakhstan by I. Chaplina and (4) the same for the Tyva Republic by O.E. Kosterin and V.V. Zaika. Taxonomic studies carried out by A.Yu. Haritonov, E.I. Malikova, O.N. Popova and O.E. Kosterin, aim to resolve some systematic puzzles and to clarify the status of problematic taxa.

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